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Canadian Science Advisory Secretariat
Maritimes Region | Science Response 2016/036

4VWX HERRING 2016 UPDATE REPORT

Context

Maritimes DFO Resource Management has requested that DFO Science provide an update on the science advice for NAFO Divisions 4VWX Atlantic Herring (*Clupea harengus*) management unit in support of the 2015/2016 fishery. The last assessment of 4VWX herring stock was conducted in March 2015 (DFO 2015). The biological and fishery information of the 4VWX herring stock forms the basis for establishing quota for the 2015/2016 fisheries, as required in the Integrated Fisheries Management Plan (IFMP). This Science Response reviews and updates biological and fishery information of the 4VWX herring stock including an evaluation of the southwest Nova Scotia/Bay of Fundy (SWNS/BoF) spawning component, a compilation and review of information regarding the offshore Scotian Shelf spawning component and the coastal Nova Scotia (NS) spawning component, an update on southwest New Brunswick (SWNB) migrant juvenile fishery component, and an evaluation of the status of the fishery with respect to the conservation Limit Reference Point (LRP). This Response also reviews whether the goals of the rebuilding plan are being met.

This Science Response Report results from the Science Response Process April 8, 2016, on the Stock Status Update of Herring in Northwest Atlantic Fisheries Organization (NAFO) Fishing Area 4VWX.

Background

The 4VWX herring management unit contains a number of spawning areas, separated to various degrees in space and time. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components (see the Appendix for map of place names):

- SWNS/BoF spawning component (includes Scots Bay, German Bank, and Trinity Ledge);
- Offshore Scotian Shelf spawning component (includes The Patch and Western Hole);
- Coastal (South Shore, Eastern Shore, and Cape Breton) NS spawning component; and
- SWNB migrant juveniles (NB weirs).

Each component except SWNB migrant juveniles has several spawning areas, and there is mixing of fish among spawning components outside of the spawning period. The Total Allowable Catch (TAC) for the SWNS/BoF is 50,000t. The Offshore Scotian Shelf has an allocation of 12,000t, and the coastal NS fishing areas have allocations based on the recent 5-year average of observed spawning stock biomass (SSB[1]).

The 2003 (Evergreen) Scotia-Fundy Herring IFMP set out principles, conditions, and management measures for the 4VWX herring fisheries (DFO 2003). The main principle stated in the plan is "the conservation of the herring resource and the preservation of all of its spawning components". The three conservation objectives are: to maintain the reproductive capacity of herring in each management unit, to prevent growth overfishing, and to maintain ecosystem integrity/ecological relationships ("ecosystem balance"). Progress against these conservation

[1] Throughout this document, spawning stock biomass (SSB) refers to the spawning stock biomass observed at the time of the acoustic surveys.

objectives was evaluated during the March 2015 assessment (DFO 2015). A major review of the assessment framework was conducted in 2006/2007 (DFO 2007) followed by a framework meeting in 2011. A model was not chosen during the framework meeting; however, recommendations for the assessment were provided (DFO 2011). In 2012, a conservation LRP of 377,272t, the average SSB in Scots Bay and German Bank for the period 2005-2010, was set (Clark et al. 2012). The total SSB in these two areas is evaluated based on the 3-year moving average with respect to this LRP.

The herring fisheries in 4VWX have always been dominated by purse seine (e.g. 81-99%, 1981-2015). Other gear types include weir, gillnet, shutoff, and trap.

Analysis and Response

Landings

The landings for the period October 15, 2014, to October 14, 2015, (the 2014/2015 quota year) were 49,024t against a TAC of 50,000t for the SWNS/BoF component (Table 1).

Table 1. Reported landings (rounded to thousands of tonnes) and total allowable catch for the 4VWX herring management unit by component from 2006 to 2015 with averages for recent and prior decades.

Year	Avg. 1970 -79	Avg. 1980 -89	Avg. 1990 -99	Avg. 2000 -09	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
4WX SW Nova Scotia/ Bay of Fundy TAC[1]	106	106	112	69	50	50	55	55	55	50	50	50	50	50
4WX SW Nova Scotia/Bay of Fundy[1]	131	131	96	66	50	50	55	54	46	50	48	47	50	49
4VWX Coastal Nova Scotia[2]	<1	<1	4	7	7	5	4	10	6	4	3	4	5	5
Offshore Scotian Shelf[2]	38	<0.1	13	6	10	5	1	9	12	10	1	2	<0.1	2
SW New Brunswick[2]	26	24	24	15	13	31	6	4	11	4	1	6	2	<0.2
Total Landings	172	155	137	93	79	92	66	77	74	68	52	58	57	56

1 - Quota year from October 15th of the preceding year to October 14th of the current year
2 - Calendar year from January 1st to December 31st

Additional landings of 7,102t were taken in the non-quota stock components (outside the quota area) for a total of 56,126t. Southwest NB weirs and shutoffs landings in 2015 decreased to 146t (Table 1), a historical low. The landings increased for the Offshore Scotian Shelf but remained below the 12,000t allocation for the area. Landings for the 4VWX Coastal NS component, primarily from gillnet gear type, remained approximately the same at 5,166t. Within the SWNS/BoF component, there was a decrease in catches from the German Bank area defined as the acoustic catch box from 50% of the total TAC in 2014 to 42% in 2015. Within this catch area, purse seiners decided on a cap of 50% of the TAC in 2013 and 40% in 2014 for implementation in the subsequent fishing years. Landings by defined fishing grounds decreased in 2015 from Grand Manan, Gannet Dry Ledge, and Long Island and increased for Scots Bay and NB Coastal. For SWNS/BoF, landings in 2015 were 1,200t (2%) less than in 2014.

Southwest Nova Scotia/Bay of Fundy

Age Structure

The 2015 fishery catch-by-number (Figure 1) was dominated by 2-year olds (40% overall) with widespread occurrence in all areas except on the main spawning grounds in Scots Bay and German Bank, where the landings are dominated by mature fish. Catch-by-weight was dominated by ages 2, 4, and 7 (at 15-18%) with age 4 dominating slightly. Age 4 catches were largest in the month of June, particularly in the Scots Bay, German Bank, and Gannet/Dry Ledge areas. Another important feature of the 2015 catch-at-age was the generally even distribution of ages 3 to 8 in terms of number and weight with an overall increase in numbers of

ages 7+ from 11% in 2014 to 15% in 2015. Based on the age structure, the total number of fish removed by the fishery in 2015 was estimated to be 5 million fish (1%) less than in 2014. In 2015, a greater number of age 8 and 9 fish were landed than in the previous 5 years, but the numbers of fish aged 6 and older in the commercial landings are less than those in the 1965-1995 time period (Figure 2).

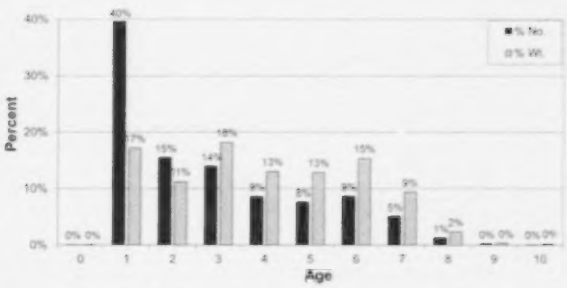

Figure 1. Fishery catch-at-age (percentage numbers and percentage weight) for Southwest Nova Scotia/Bay of Fundy spawning component (2014-2015 quota year).

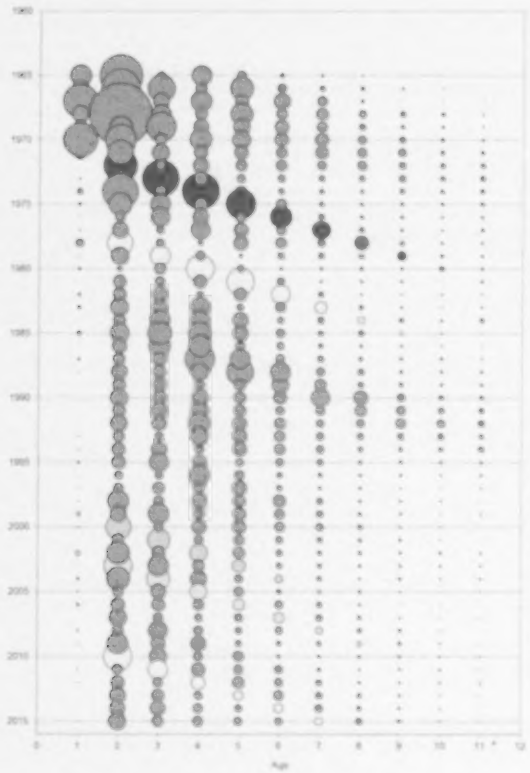

Figure 2. Historical relative numbers-at-age (denoted by circle size) in the commercial landings for Southwest Nova Scotia/Bay of Fundy spawning component from 1965-2015. Selected strong year-classes are indicated by colours.

The acoustic surveys catch-at-age continues to have a broad age distribution of spawning fish from ages 3-11. In the acoustic surveys catch-at-age, the proportion of fish (by numbers)-at-age 6 and older was 41% (same as in 2014). In the fishery, the proportion of fish (by numbers)-at-age 6 and older was 23% (22% in 2014), which is substantially lower than the acoustic surveys catch at age due to the inclusion of juveniles. The mean age acoustic catch-at-age increased slightly to 5.3 years in 2015 from 5.0 years in 2014 and is the highest value since 2007. Age 4 fish were dominant in the 2015 Scots Bay surveys (34% by number) followed by age 7 fish at 18%. German Bank was equally represented by age 4 and 5 fish at 28% and 25%, respectively. The overall acoustic age composition indicates the incoming 2011 year-class (at age 4) as relatively strong while the 2007 and 2008 year-classes (ages 7-8) remain important in the spawning component (Figure 3).

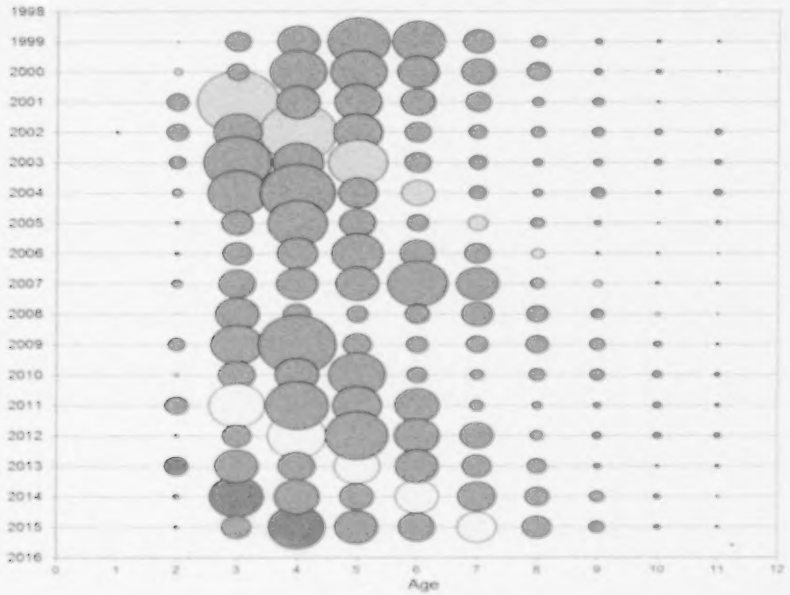

Figure 3. Relative numbers-at-age (denoted by circle size) in the acoustic catch-at-age for southwest Nova Scotia/Bay of Fundy spawning component from 1999-2015. Selected strong year-classes are indicated by colours.

Acoustic Surveys

Table 2 summarizes the results of the 2015 acoustic surveys for the SWNS/BoF component. Inbox and outbox refers to survey tracks within and outside the designated survey boxes, respectively. There were 6 surveys in Scots Bay, 5 on German Bank (3 other surveys were excluded), and 1 on Trinity Ledge (1 other survey was excluded). Excluded surveys were not used because they were conducted less than 10 days after the previous survey.

The overall acoustic biomass estimates (Scots Bay, Trinity Ledge, and German Bank) decreased slightly in 2015 to 462,241t (95% confidence interval (C.I.): +/- 32,036t) from 463,929t (95% C.I.: +/- 43,393t) in 2014. This moves the overall acoustic biomass estimate to 3% above the long-term average (1999-2015) of 450,447t. Most of the increase occurred in Scots Bay with 285,194t (95% C.I.: 26,242t) in 2015 and 226,123t (95% C.I. +/- 29,542t) in 2014. The German Bank SSB decreased from 233,034 (95% C.I.: +/-65.854t) to 176,389 (C.I.: +/- 41.899t) in 2015, the lowest biomass estimate recorded since surveys began. Caution is warranted in this area as a result of this continuing downward trend.

Table 2. Acoustic surveys spawning biomass index for Southwest Nova Scotia/Bay of Fundy spawning component for 1999 to 2015 (rounded to thousands of tonnes).

Location/Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average 2005-2010*	Average 1999-2015
Scots Bay (inbox)	46	185	216	129	123	115	21	32	51	23	82	42	106	144	67	221	260	42	110
Scots Bay (outbox)	n/d	n/d	n/d	n/d	n/d	n/d	n/d	n/d	2	0	6	12	35	41	9	5	25	11	15
Scots Bay Total	46	185	216	129	123	115	21	32	53	23	88	54	141	185	76	226	285	45	118
German Bank (inbox)	495	334	257	416	349	392	269	291	495	239	396	235	289	278	254	230	176	321	317
German Bank (outbox)	n/d	n/d	n/d	n/d	n/d	n/d	n/d	5	4	2	2	19	11	10	11	3	0	6	7
German Bank Total	495	334	257	416	349	392	269	295	499	241	398	254	300	288	265	233	176	326	321
Scots Bay and German Total	541	519	473	546	472	507	290	327	552	264	485	308	441	473	341	459	462	371	439
Trinity Ledge	4	1	15	9	12	12	11	16	3	1	2	2	7	3	1	5	1	6	6
Spec Buoy (spring)	n/d	n/d	1	n/d	1	n/d	1	n/d	0	0	n/d	2	0	n/d	n/d	n/d	n/d	1	1
Spec Buoy (fall)	n/d	n/d	88	n/d	n/d	n/d	n/d	0	n/d	n/d	n/d	n/d	n/d	n/d	n/d	0	0	0	44
Overall Stock Area	545	521	577	554	485	519	301	343	556	265	487	312	449	476	342	464	462	377	450
Seal Island	n/d	n/d	4	1	12	n/d	n/d	10	n/d	n/d	n/d	n/d	1	n/d	n/d	n/d	n/d	10	6
Browns Bank	n/d	n/d	45	n/d	n/d	n/d	n/d	8	n/d	n/d	n/d	n/d	n/d	n/d	n/d	0	0	8	26
Total All Areas	545	521	626	556	497	519	301	361	556	265	487	312	450	476	342	464	462	380	455

* Note: Average 2005-2010 = Limit Reference Point (German Bank and Scots Bay total only)
n/d = no data for that year in that category
Zero = surveys conducted but the numbers recorded were either 0 or less than 500t (rounds to 0 thousand t)

Limit Reference Point

The 3-year moving average for the acoustic surveys estimate (Scots Bay and German Bank combined) is above the LRP point by 13 % and 12 % in 2014 and 2015, respectively (Figure 4). Although the 2015 acoustic surveys estimate (461,600t) increased, the 3-year moving average (420,500t) decreased slightly from the 2014 estimate resulting in little change in the last two years.

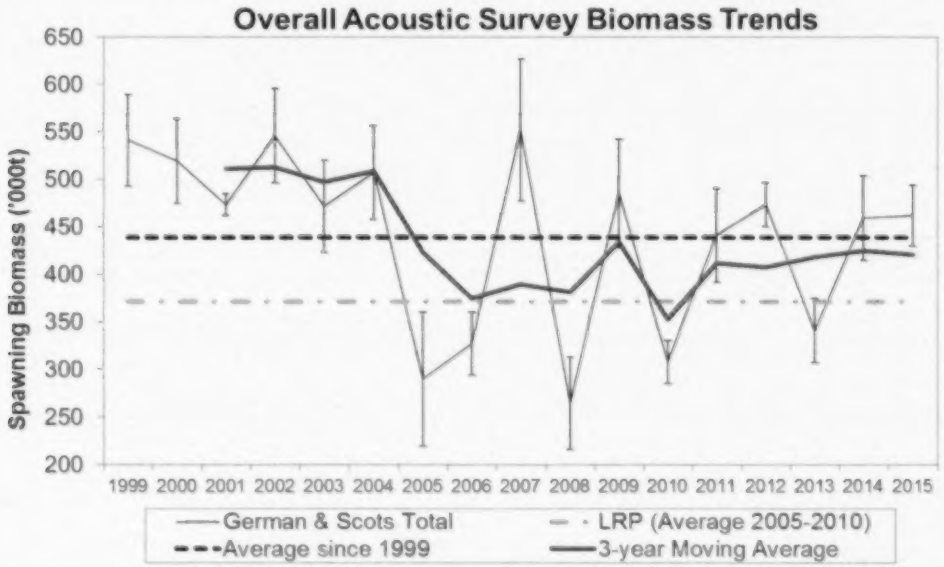

Figure 4. Relative spawning stock biomass index (with 95% standard errors), the calculated 3-year moving average, the average since 1999, and the limit reference point (LRP) for the Southwest Nova Scotia/Bay of Fundy spawning component (German Bank and Scots Bay).

Offshore Scotian Shelf Component

In 2015, offshore landings increased to 1,809t from 58t in 2014 (Table 1); however, landings remain below the allocation limit of 12,000t. Most landings were caught by purse seiners in May and June, in the vicinity of The Patch (see map in the Appendix). The age composition of the commercial catch was primarily adult herring with ages 5, 6, and 7 dominating by numbers (64%) and weights (67%). An additional by-catch of 40t was reported from groundfish otter trawl fisheries for Silver Hake on the Scotian Shelf. The DFO summer Research Vessel survey mean catch-per-tow for the 4WX offshore area increased to 167 fish from 91 in 2014.

Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia Spawning Component

Allocations for the coastal NS spawning component are based on the recent 5-year average of observed acoustic SSB, where availbale. Landings in the Little Hope/Port Mouton area increased in 2015 to 4,160t (from 3,596t in 2014) against the 2015 allocation of 3,772t (Table 3). In the Eastern Shore area, landings decreased in 2015 to 1,001t (from 1,163t in 2014) against the 2015 allocation of 1,066t. No landings were reported for Glace Bay in 2015. The Bras d'Or Lakes area remained closed to herring fishing. In 2015, the age composition of the catch for the coastal component was primarily adult herring from this size selective gillnet fishery with a substantial proportion of the catch (94% by numbers) age 5 and older.

In 2015, the SSB for the Little Hope/Port Mouton area increased to 145,395t from the 46,077t in 2014, the highest since surveys started and well above the recent 5-year average of 61,511t (Table 4). The SSB in the Halifax/Eastern shore area also increased to 68,562t (2015) from 9,586t (2014) and above the recent 5-year average of 18,837t. The reason for these increases is not known and could be an anomaly rather than an increase in abundance. The same survey protocols were used in 2015 as in previous years. There was no evidence of a large influx of first time spawners or spawning in new areas. Caution is always warranted in applying the survey SSB as an absolute tonnage of herring in the water.

No survey was completed in Glace Bay in 2015 and no catch was reported.

Table 3. Recorded landings and allocations (tonnes) of herring from major gillnet fisheries on the Coastal Nova Scotia spawning component for 1996 to 2015.

Landings and Allocations (t)		Avg. 99-05	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Little Hope/Port Mouton	Catch	2,393	3,140	1,510	1,108	3,731	3,106	2,576	2,150	2,499	3,596	4,160
	Allocation	2,086	3,952	4,008	2,944	2,172	2,454	2,094	2,188	2,790*	3,577	3,772
Halifax/Eastern Shore	Catch	2,246	3,350	3,720	2,348	5,885	2,302	908	771	1,390	1,163	1,001
	Allocation	2,255	4,323	5,367	5,103	3,857	4,373	4,188	2,920	2,427	1,959	1,066
Glace Bay	Catch	1,340	85	45	12	4	11	0	7	2	1	0
Bras d'Or Lakes	Catch	54	0	0	0	0	0	0	0	0	0	0

*original allocation of 2,387t was increased by 400t

Table 4. Estimated herring acoustic spawning stock biomass (SSB) (tonnes) and recent 5-year average for the Coastal Nova Scotia spawning component areas.

Acoustic Survey SSB (t)	Avg. 98-05	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Avg last 5 years
Little Hope/Port Mouton	29,088	24,100	2,800	14,500	36,600	26,700	28,796	12,756	74,532	46,077	145,395	61,511
Little Hope Allocation	2,086	3,952	3,825	2,938	2,295	2,530	2,094	2,188	2,790*	3,577	3,772	2,804
Halifax/Eastern Shore	31,944	68,900	28,300	30,300	54,200	27,700	5,498	3,668	6,870	9,586	68,562	18,837
Halifax Allocation	2,255	4,323	5,005	4,785	3,747	4,177	4,188	2,920	2,427	1,959	1,066	2,512
Glace Bay	13,116	n/s	240	500	100	8	51	n/s	50	n/s	n/s	51
Bras d'Or Lakes	300	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s

n/s - no survey; *original allocation of 2,387t was increased by 400t

SW New Brunswick Migrant Juveniles

The New Brunswick weir and shut-off fishery catches migrant juvenile herring. In 2015, landings decreased from 2,149t in 2014 to a historical low of 146t (Figure 5). Fish caught in the New Brunswick weir and shutoff fishery were primarily juveniles (7% age 1 and 92% at age 2 by numbers). The number of weirs with catches decreased in 2015 to 11 from 26 in 2014.

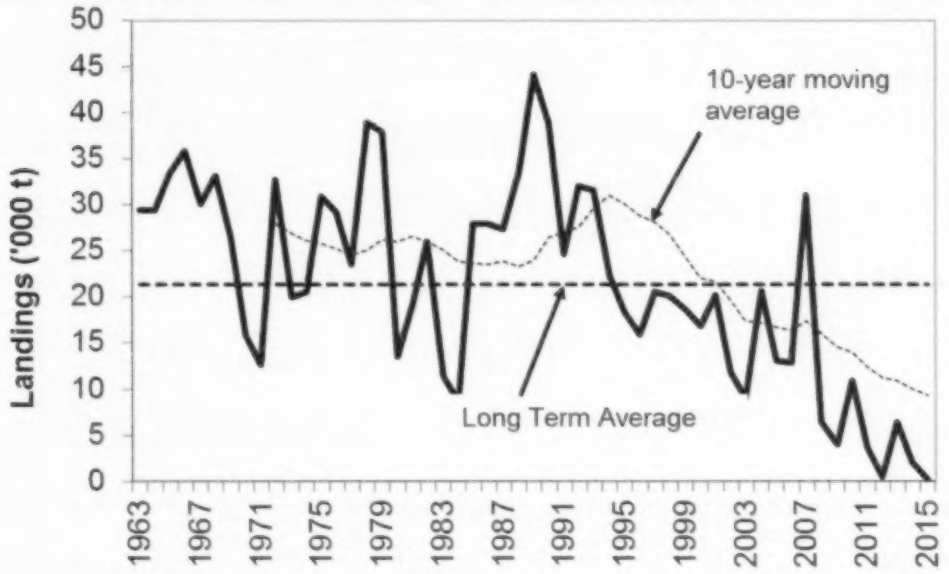

Figure 5. Herring landings ('000t) from Southwest New Brunswick weirs and shutoff fishery from 1963-2015 with long term average and 10-year moving average.

Conclusions

Southwest Nova Scotia / Bay of Fundy Spawning Component

The acoustic spawning stock biomass estimate decreased slightly. There was an increase in Scots Bay and a decrease on German Bank. Although there is uncertainty in the acoustic biomass estimates, the longer-term trends show an increasing trend in Scots Bay since 2005 and a decreasing trend in the German Bank area from 1999 to present. In 2015, a historical low biomass was recorded on German Bank. The decreasing trend indicates that caution is warranted on German Bank. The SSB for Trinity remains low relative to values observed in the early 2000s.

The 3-year moving average decreased slightly and, as such, a harvest strategy that continues to exercise caution is warranted. The broad age ranges observed in the commercial catch indicates that this conservation objective is generally being met. Table 5 provides a summary of the observations and conclusions for each of the corresponding objectives in the IFMP.

Table 5. Observations and conclusions on conservation objective elements from the management plan for SW Nova Scotia / Bay of Fundy spawning component in 2015.

Objectives in Management Plan	2015: Observations and Conclusions
Persistence of all spawning components	Spawning observed in Scots Bay and German Bank. Spawning activity could not be determined on Seal Island or Browns due to a lack of fishing or survey effort. Trinity Ledge had minimal spawning documented.
Maintain biomass of each component	Although there is uncertainty in the acoustic biomass estimates, the longer-term trends show an increasing trend in Scots Bay since 2005 and a decreasing trend in the German Bank area from 1999 to present. In 2015, a historical low biomass was recorded on German Bank. The SSB for Trinity remains low relative to values observed in the early 2000s.
Maintain broad age composition	Currently broad ranges of ages are in the commercial landings (2-9), as well as in the acoustic surveys catch- at- age (3-11). In 2015, the proportion of the landings older than age 5 was 23% the second highest since 1995.
Maintain long spawning period	Start of spawning in 2015 for both Scots Bay and German Bank was a few days later than in 2014 based on survey results. The trend of an earlier start date is seen in both areas but an earlier end date is also seen on German Bank. Virtually no spawning occurred on Trinity Ledge.
Fishing mortality at or below F0.1	Fishing mortality could not be determined. Relative exploitation rates based on acoustic SSB and landings were approximately the same in 2015 as in 2014.
Maintain spatial and temporal diversity of spawning	Spawning in the German Bank area displays a trend of an earlier end date. Spatially, the German Bank area had a similar distribution to previous years. Duration of spawning in Scots Bay was similar in comparison to previous years. Spatially, the Scots Bay area had a similar distribution as in previous years. Therefore, spawning periods are being maintained both temporally and spatially on the two major spawning grounds Trinity Ledge spawning is very restricted in space and time.
Maintain biomass at moderate to high levels	There was a slight decrease in the overall acoustic SSB, however, in the last two years the acoustic SSB has been above the long-term average (1999-2014).
Maintain three-year moving average above the limit reference point	The three-year moving average increased above the LRP in 2011 and has shown little increase since 2012. The slightly increasing trend seems to be leveling off in 2015.

Offshore Scotian Shelf Component

There was an increase in the landings from the offshore banks from the low of 58 t in 2014 to 1,803t in 2015. In the absence of recent information about stock status, there is no basis for evaluating the current catch allocation of 12,000t. Structured acoustic surveys are needed to obtain data on the stock in the offshore area.

Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia Spawning Component

High biomass estimates were documented in Little Hope and Eastern Shore areas; however, it is not clear if this is an anomaly or whether this increase in biomass will continue to be observed in future years. There have been no research or acoustic surveys completed in the Bras d'Or Lakes since 2000. It is recommended that this area remain closed to herring fishing.

SW New Brunswick Migrant Juveniles

The landings in the weir and shut-off fishery in 2015 were at an historical low. The degree to which this reflects abundance is unknown.

Contributors

Name	Affiliation
Rabindra Singh (Lead)	DFO Science, Maritimes Region
Laura Hussey-Bondt	DFO Fisheries and Aquaculture Management, Maritimes Region
Jamie Gibson (reviewer)	DFO Science, Maritimes Region
Julien Gaudette (reviewer)	DFO Science, Maritimes Region
Lottie Bennett	DFO Science, Maritimes Region

Approved

Alain Vézina
Regional Director of Science, DFO Maritimes Region
Dartmouth, Nova Scotia
Ph. 902-426-3490
Date:

Sources of Information

Clark, D.S., K.J. Clark, R. Claytor, S. Leslie, G.D. Melvin, J.M. Porter, M.J. Power, H.H. Stone, and C. Waters. 2012. Limit Reference Point for Southwest Nova Scotia / Bay of Fundy Spawning Component of Atlantic Herring, *Clupea harengus* (German Bank and Scots Bay). DFO Can. Sci. Advis. Sec. Res. Doc. 2012/025.

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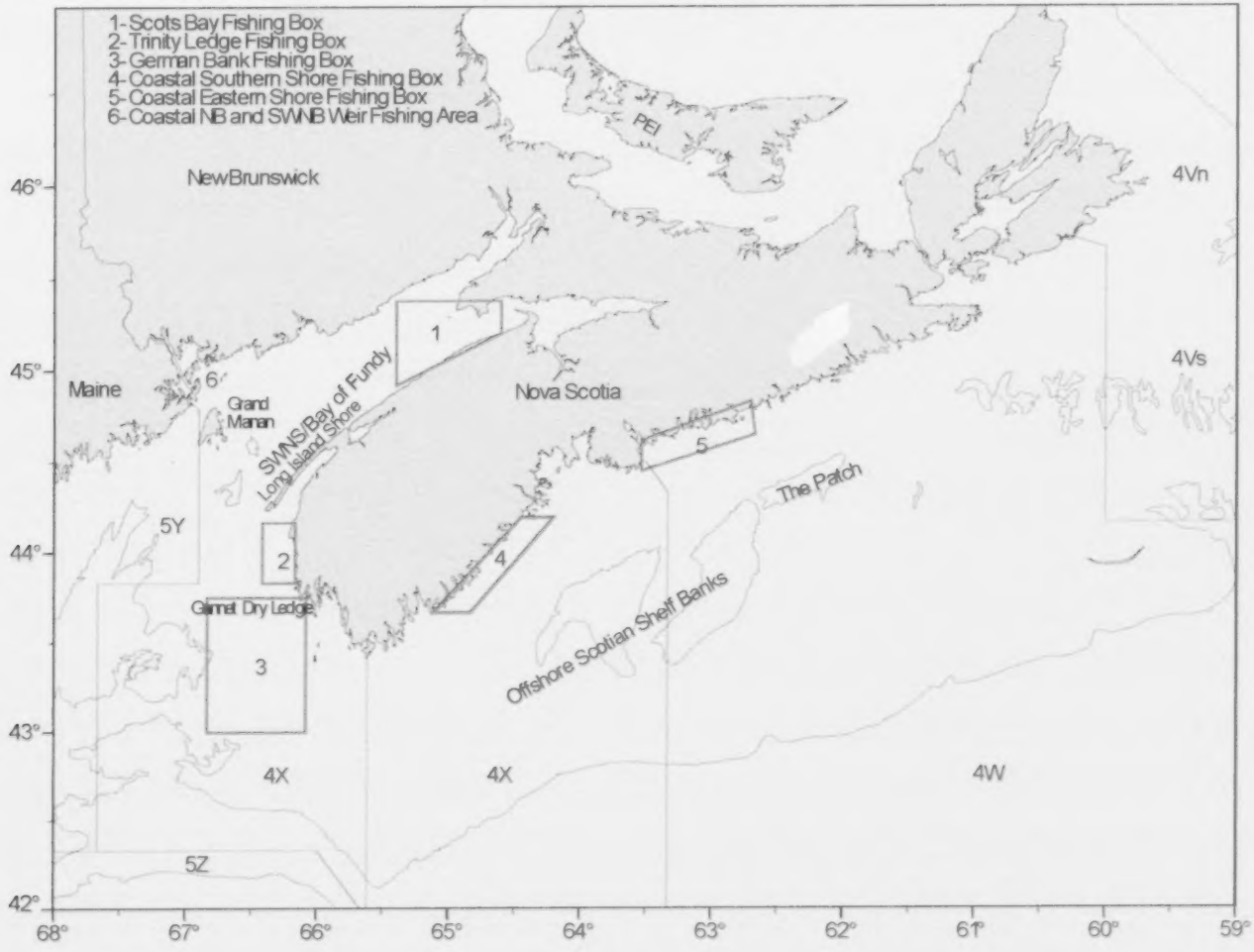
Appendix

Appendix 1. Place names and fishing locations for SWNB/BoF, coastal NS (South Shore and Eastern Shore), Offshore Scotian Shelf and SWNB weirs. The vertical blue line indicates the outer boundary of the SWNS/BoF stock component.



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Center for Science Advice (CSA)
Maritimes Region
Fisheries and Oceans Canada
Bedford Institute of Oceanography
1 Challenger Drive, PO Box 1006
Dartmouth, Nova Scotia B2Y 4A2

Telephone: 902-426-7070
E-Mail: XMARMRAR@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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